Automated programmable scanning plane orientation of CERES instruments

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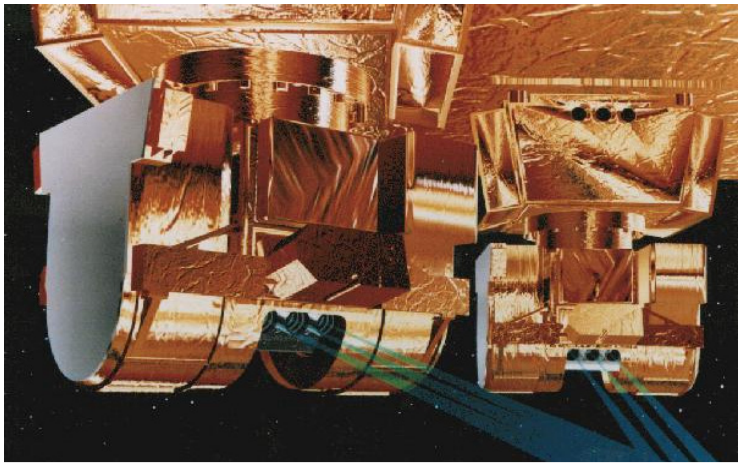
Presentation Outline

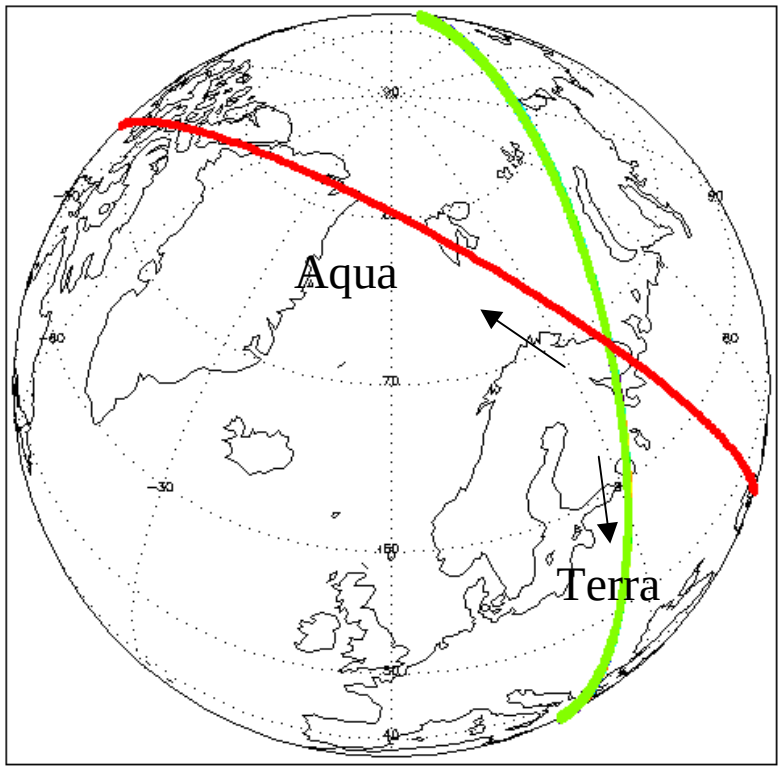
- CERES instruments
- Programmable azimuth plane scan mode
- Automated web-based commanding
- Special campaigns involving CERES
- Concluding remarks

Clouds and the **E**arth's **R**adiant **E**nergy **S**ystem Instrument



- Narrow field-of-view (15x30km at nadir) scanning radiometer:
  - Shortwave channel (0.3-5μm),
  - Total channel (0.3-100μm),
  - Window channel (8-12μm)
- PFM on board TRMM (1998, failed 06/2000)
- FM1 & FM2 on board Terra (in service from 03/2000)
- FM3 & FM4 on board Aqua (in service from 06/2002)

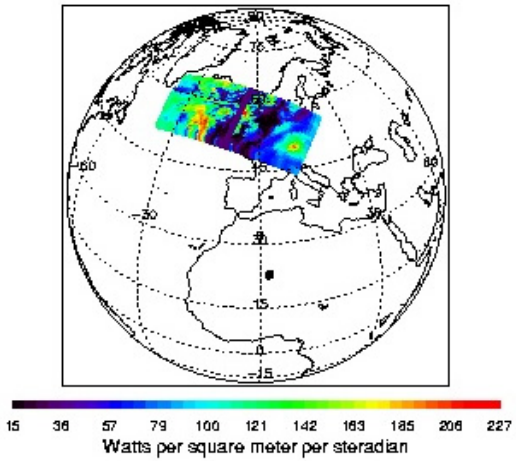
Terra & Aqua orbits



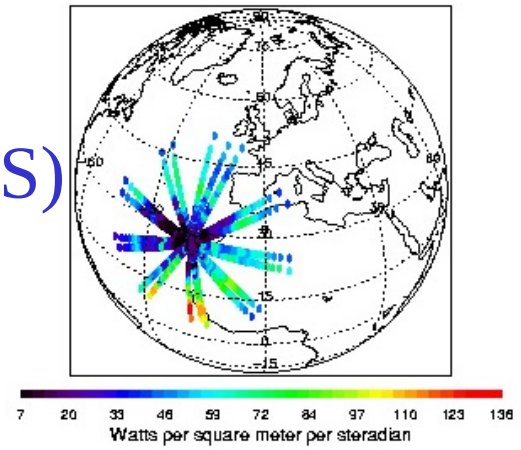
- Sun-synchronous, inclination angle 98.2º and 81.8º
- Equator crossing time: 10:30AM and 1:30PM
- about 15 minutes apart at nodes

CERES normal operation modes

- Cross-track (XT) Scan



- Rotational Azimuth Plane Scan (RAPS)



Special mode

Programmable Azimuth Plane Scan (PAPS) mode:

- Scanning plane orientation follows a prescribed schedule
  - ✓ Step-wise changes of the azimuth angle
  - ✓ Time and angle changes depend on satellite position in an orbit
- Increases sampling by an order of magnitude

PAPS applications:

- Special observations
  - ✓ Earth targets
  - ✓ Matching viewing geometry of other instruments
  - ✓ Sampling within required scan plane orientation

CERES special coverage tools

- Web-based application
  - http://asd-www.larc.nasa.gov/PAPS/CERES_PAPS.html
- Relative azimuth (RAZ) predictions
  - Obtain 7-day satellite ground track file from Goddard
  - Compute scanner orientation for each scan (every 6.6s)
  - Generate daily RAZ prediction files for commanding
- Automated Command uploads
  - Stored Command Sequence (SCS) for Aqua
  - One-Day Sequence (ODS) for Terra

Field campaigns with CERES

- Building refined angular distribution models (AMD)
  - Sampling in the principal (solar) plane
  - Over oceans, snow, land
  - FM3 on Aqua
  - February, 2003; October, 2003; December, 2003
- Validating GERB radiation measurements
  - Scanning in the GERB viewing geometry
  - FM2 on Terra
  - May-June, December, 2003

Principal Plane Scanning

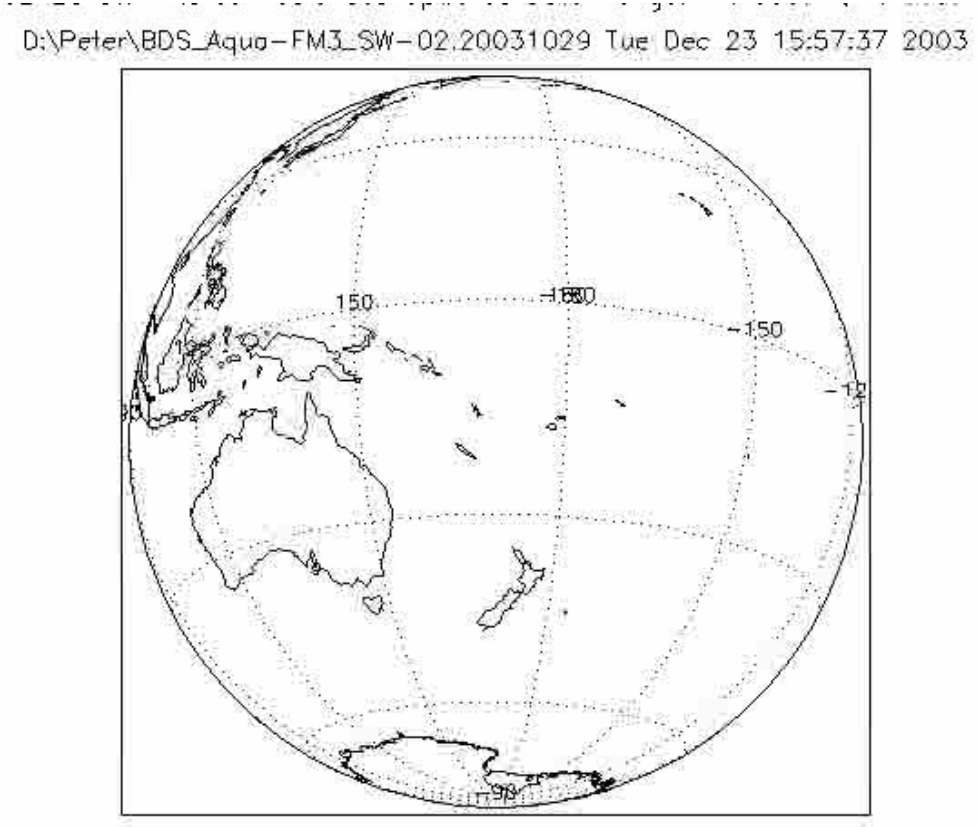
To build refined angular distribution models

- **A**nisotropy of Earth scenes highly variable in the solar plane
  - ✓ Sun-glints over clear oceans
  - ✓ Hot spots and shadows over land
  - ✓ Rainbow and glory features in overcast
- PPS campaigns in Feb., October, and Dec., 2003
  - ✓ PAPS keeps the scanning in the solar, or principal plane
  - ✓ FM3 or FM4 on Aqua
  - ✓ Up to 14 orbits per day of 40 min scanning

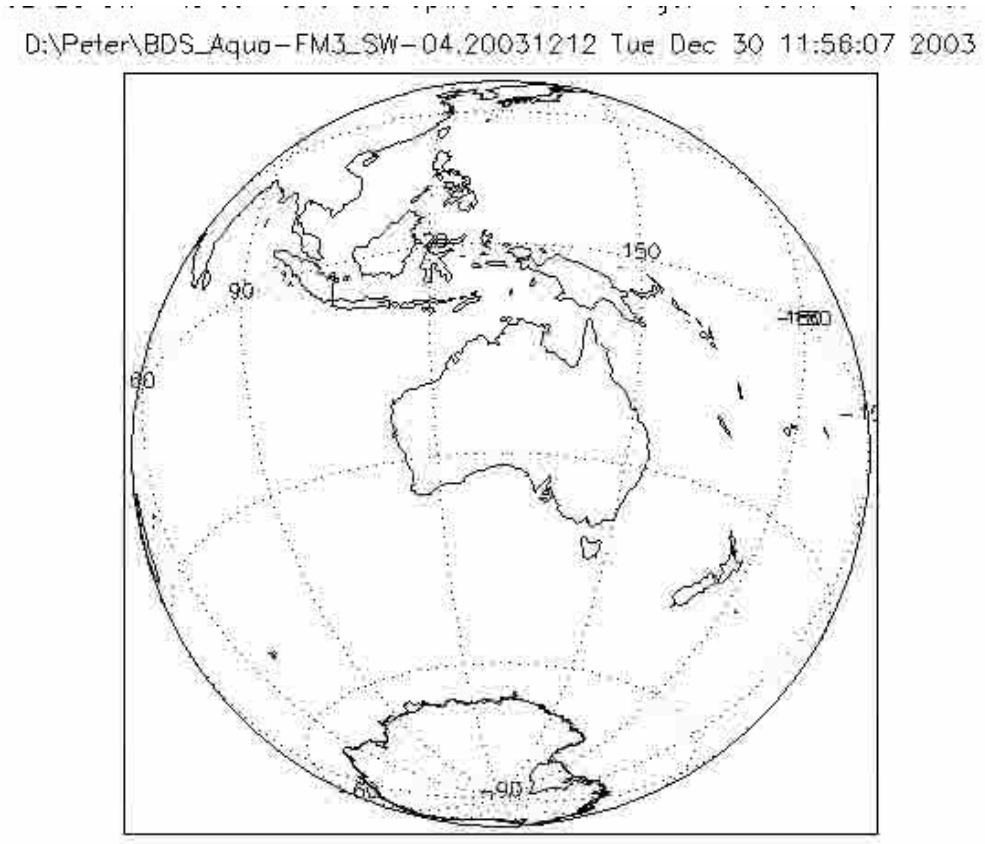
PPS execution

- Stored Command Sequence
  - ✓ Command macros stored aboard Aqua
  - ✓ Computed based on the SUN avoidance angle (16deg.)
  - ✓ Valid for a wide range of the SUN declination angles
  - ✓ Only the start time is uploaded daily << max number of commands
- PPS campaigns
  - ✓ Over ocean: up to 4 orbits per day
  - ✓ Over Antarctica: up to 14 orbits per day (39’30” each)

PPS over ocean

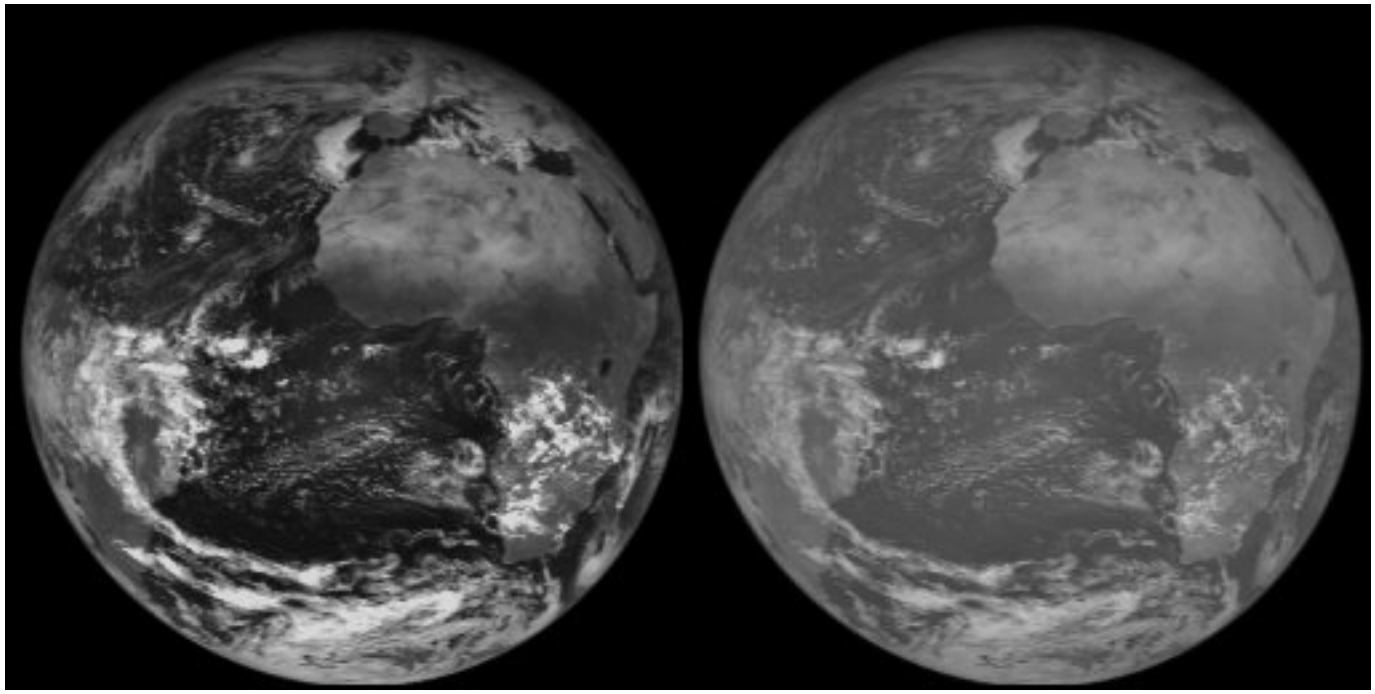


PPS over Antarctica



GERB measurements

- **G**eo-stationary **E**arth **R**adiation **B**udget instrument
  - ✓ On board MSG located at 10.5 W
  - ✓ Array of 256 detectors covering the visible portion of Earth
  - ✓ Short and long-wave radiation image every 15min.



CERES/GERB validation

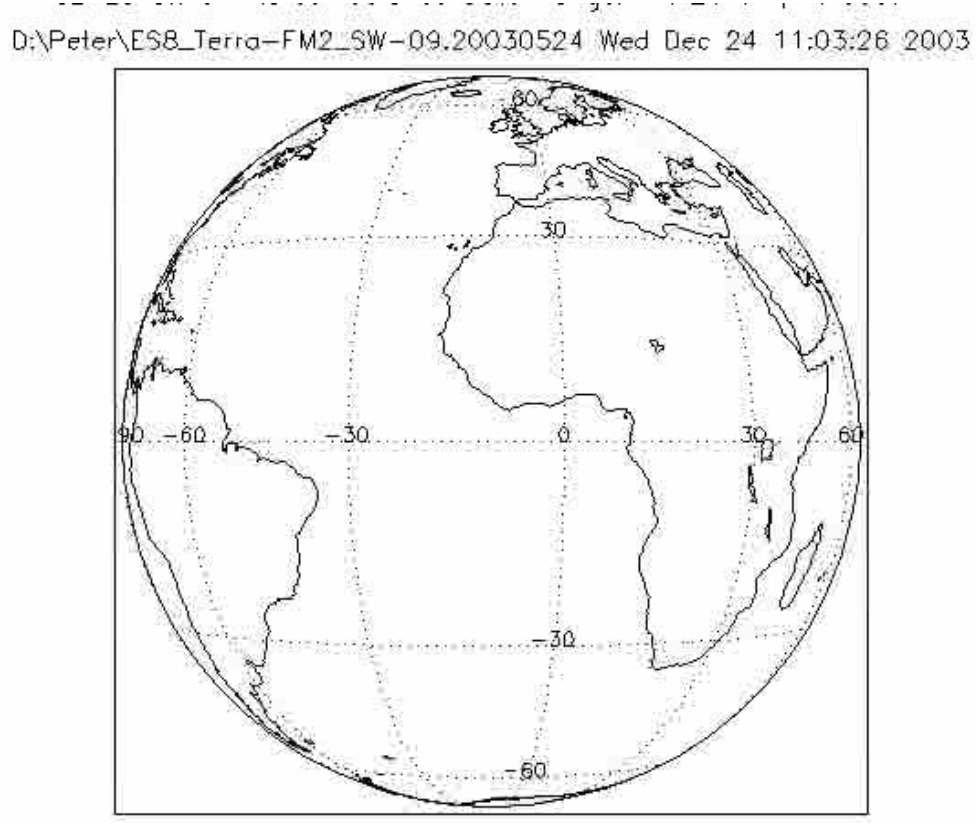
To validate GERB radiances for ERB dataset

- CERES/GERB campaign on May 24-June 6, Dec. 11-31, 2003
  - ✓ PAPS matches GERB viewing geometry
  - ✓ FM2 on Terra
  - ✓ 4 daytime orbits per day for about 25 min scanning
  - ✓ CERES as a “transfer function” between detectors

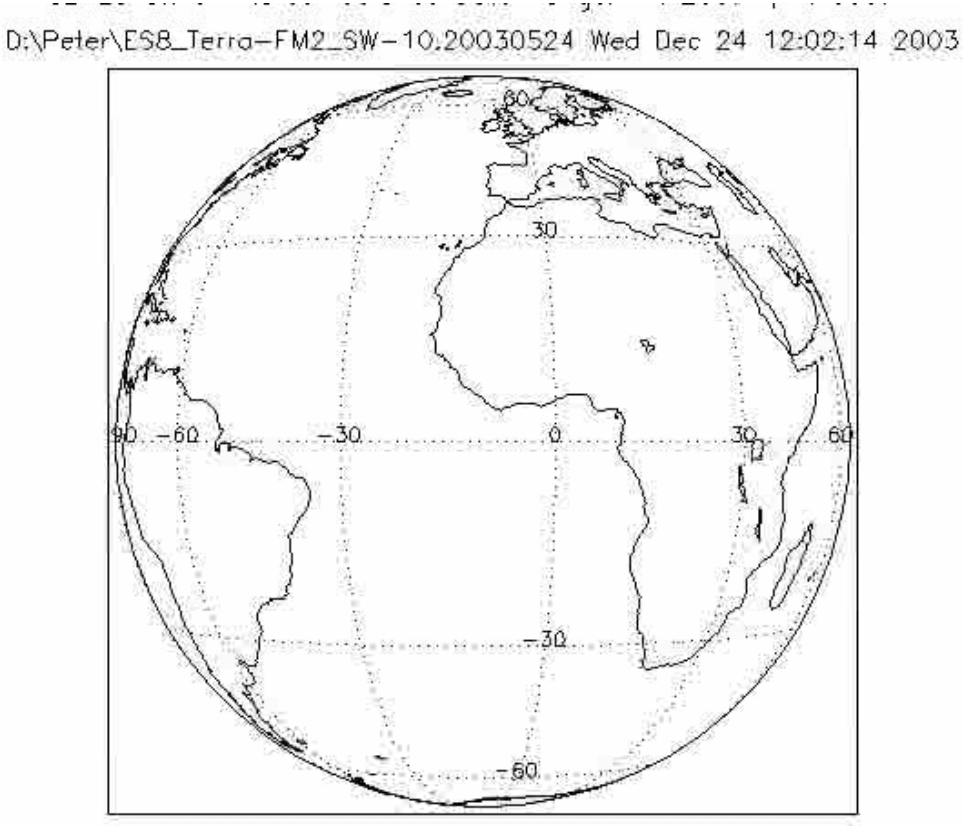
CERES/GERB execution

- One-Day Sequence
  - ✓ Up to 1K commands per day may be uploaded
  - ✓ ODSs are automatically created on a web server
  - ✓ Secure transfer to a directly linked computer
  - ✓ Eliminates the need for keying-in daily commands
- CERES/GERB campaigns
  - ✓ 4 daytime orbits per day

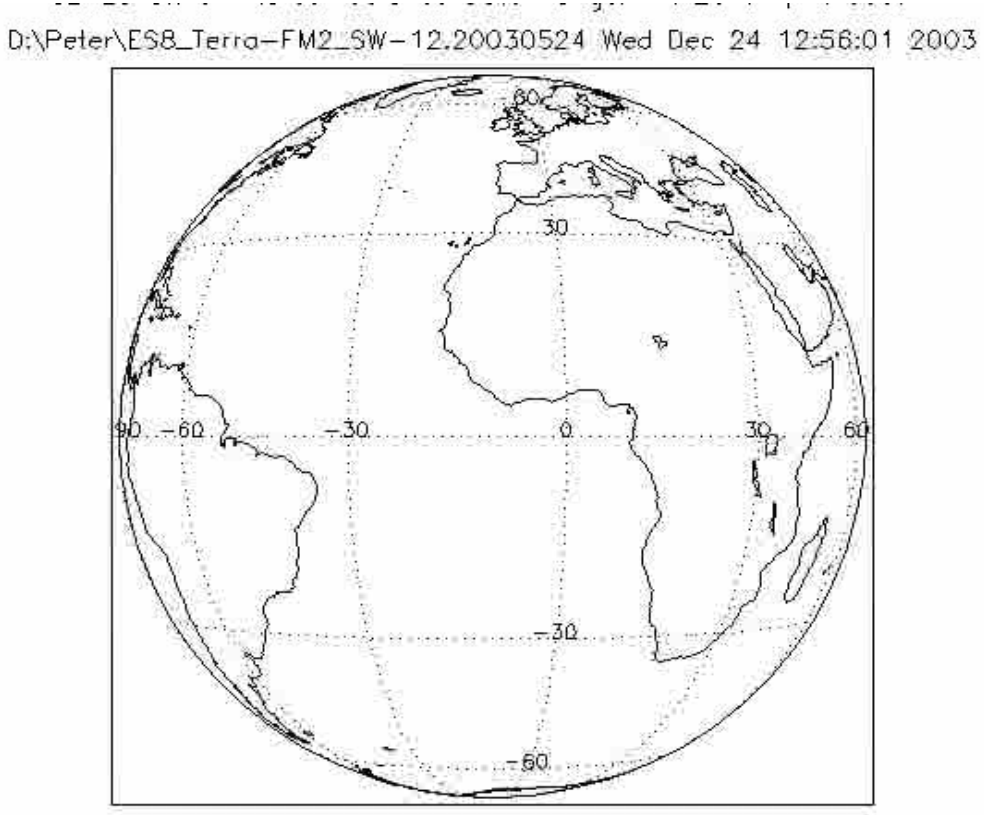
CERES/GERB daily scanning



CERES/GERB daily scanning



CERES/GERB daily scanning



Concluding remarks

- CERES participated in variety of campaigns
- PAPS mode for special observations
- Planning tools reside on a website
- Rapid response due to automation
- Free service to the science community

http://asd-www.larc.nasa.gov/PAPS/cgi-bin/rygar.cgi